

## **APPENDIX C**

### **Hazen Research Inc. Holoflite® Dryer Demonstration Results**



## **HAZEN RESEARCH INC. HOLOFLITE® DRYER DEMONSTRATION RESULTS**

January 9, 2001. Dredged-and-dewatered sediment was delivered to the Hazen Research, Inc. (Hazen), facility in Golden, Colorado, in four 55-gallon drums. The tackiness of the sediment hindered its flow through the feed hopper of the bench-scale dryer. After drying a portion of the sediment from one drum in a drum dryer, Hazen workers mixed dried sediment with dredged-and-dewatered sediment, using a coning-and-quartering technique. This technique was used to obtain an optimal moisture content for introducing sediment into the dryer.

January 15, 2001. Experimentation with dredged-and-dewatered and dried sediment continued in an effort to determine the right blending of material for feeding into the dryer. Work centered on the sediment in the second drum (barrel), designated Barrel 2, which, after removal from the barrel, was coned and quartered several times. The sediment was wetter than that from Barrel 1 and required more dried sediment to obtain the right consistency. Mixing was accomplished with a pug mill.

January 16, 2001. The remainder of the sediment to be used in the Holoflite®-dryer test was mixed through the pug mill to get a suitable consistency. The workable sediment was re-mixed in the pug mill and placed in plastic bags for the bench-scale test.

Overall, three drums were prepared for the Holoflite® -dryer test. One-and-three-eighths barrels of the wet soil was oven dried and remixed with one-and-five-eighths barrels of wet soil in the pug mill.

January 22, 2001. Joe Dauchy, Ken Brown, and Ken Partymiller (Tetra Tech EM Inc.); and Bob Paulson (Wisconsin Department of Natural Resources [WDNR]) arrived at Hazen and met Dennis Johnson (Hazen) at 10:30 am. Mr. Johnson took everyone present on a tour of the Hazen facility. Marta Richards (U.S. Environmental Protection Agency [EPA]) arrived and noted the need for a meeting to discuss the mixing that had occurred during the previous week and the sampling proposed for the current week. It was decided that the sampling should be reduced to six runs (from eight) because of time constraints. Also, the numbers of dioxins and furans, semivolatile organic compounds (SVOCs), and metals analyses were reduced, because they were not associated with the primary objectives. The sample-labeling protocol also was discussed. The sampling-and-analysis planning document discusses the sampling and analyses for the dryer test. The samples were labeled as follows:

HZ - Hazen Dryer Test

B1 - Batch #1

SI - Sediment in

SO - Sediment out

Example: HZB3SO = Hazen dryer test of Batch #3, Sediment Out

Sampling supplies were unpacked and shipments from laboratories were checked to ensure that everything had arrived.

January 23, 2001. Terry Carroll (Minergy) arrived today. Mr. Johnson (Hazen) stated that the balance used to measure the sediment going in and coming out of the dryer is calibrated every month by an outside contractor. The dryer was warmed up and ready to start at 9:00 am. Mr. Dauchy monitored the operational parameters (temperatures) of the dryer.

Run #1 began at 9:00 am and ended at 11:00 am. One “run”, or batch, consisted of sediment running through the dryer over a 2-hour period. Weights of the grab-and-composite soil samples collected from each run were entered in field logbooks. About 200 grams (g) of pre- and post-dryer samples were collected every half-hour during each run. Composite samples (pre- and post-dryer) from each run provided enough material for polychlorinated biphenyl (PCB), dioxin and furan, SVOC, and metals analyses. Samples were containerized and put in the appropriate coolers for shipment to Kemron Environmental Services (Kemron) in Marietta, Ohio, and Paradigm Analytical Laboratories (Paradigm) in Wilmington, North Carolina. All of the condensate was collected and weighed for each run. At the end of the run, the condensate was poured into sample containers for PCB, dioxin and furan, SVOC, and metals analyses. Runs #1 through #3 were conducted and sampled.

January 24, 2001. Run #4 began at 8:00 am. Pre- and post-dryer sediment and condensate were sampled for PCB, dioxin and furan, SVOC, and metals analysis. Videographers arrived to videotape the process. Mr. Paulson took several samples of the dried sediment and shipped them to the Wisconsin State Laboratory for analysis of PCBs. The Holoflite® dryer was drying sediment to approximately 5 percent moisture. Runs #4 through #6 were completed and sampled today. Run #6 was lengthened by 45 minutes to collect additional water for a duplicate and matrix spike/matrix spike duplicate (MS/MSD) for SVOC analysis.

January 25, 2001. Mr. Dauchy and Mrs. Richards discussed and approved collection of one set of samples for a single run (Run #7), in case the operational parameters of the dryer were different from the previous 2 days. Run #7 started at 10:30 am and ended at 12:30 p.m. Operational temperatures were recorded throughout the day. Samples were containerized and shipped to Kemron and Paradigm. The following tables summarize the analytical results of sampling conducted during the Holoflite®-dryer demonstration. Table C-1 summarizes the Sediment-In sample analytical results. Table C-2 summarizes the analytical results of the Sediment-Out composite samples. Table C-3 contains the analytical results of the condensate samples, and Table C-4 summarizes the air-sample analytical results. The data indicate a significant increase in PCB and dioxin and furan concentrations from pre-dryer to the post-dryer samples. Increases in metals and SVOC concentrations were not observed from pre-to post-dryer samples. Analytical results exhibited detections of some PCB congeners in the air and condensate samples collected during the dryer demonstration. This was probably attributable to carryover of sediment dust from the dryer chamber to the air stream exiting the dryer.

About 25 PCB congeners were specified to the laboratory for analysis. This list was based on toxic congeners listed by the World Health Organization. The 25 congeners analyzed did not correlate well with the congeners discharged to the Fox River. Total PCB values for each sample were not requested and therefore were not provided by the laboratory. A comparison of the PCB results (for both individual congeners and total PCBs) for the dredged-and-dewatered sediment and previous results obtained by the WDNR could not be made. The designated high-resolution analytical method (EPA Method 1668) (EPA 1997) was inappropriate for the elevated levels of PCBs in the sediment (parts-per- million range). Many of the analytical results exceeded the calibration range and thus were estimated.

Based on the results of the Holoflite®-dryer demonstration, it was decided that the dryer test was flawed by the carryover of dust into the air and condensate streams, as well as the congener incompatibility in the dryer test and the melter test. In addition, the increase in PCB and dioxin and furan concentrations in dried sediment could not be explained.

**TABLE C-1**  
**HAZEN HOLOFLITE® DRYER COMPOSITE SEDIMENT-IN SAMPLE RESULTS**

Analyte (parts per million)	Sample Identification					
	HZB1SI	HZB2SI	HZB3SI	HZB4SI	HZB5SI	HZB6SI
Total PCBs <sup>a</sup>	1.7	2.6	3.1	8.2	8.0	9.5
Total PCDDs/PCDFs <sup>b</sup>	0.0062	- <sup>c</sup>	-	0.024	0.016	-
Arsenic	8.7	9.7	9.3	9.3	9.2	9.6
Barium	84	84	85	78	83	83
Cadmium	0.95	0.94	0.95	0.95	1.0	1.0
Chromium	37	37	40	36	39	37
Mercury	0.94	0.91	0.89	0.92	0.88	0.87
Lead	72	71	73	75	77	74
Selenium	4.5	4.5	5.3	4.1	4.7	4.2
Silver	<3.1 <sup>d</sup>	<3.1	<3.2	<3.2	<3.1	<3.1
Total SVOCs <sup>e</sup>	<0.26	0.3	-	<0.26	<0.26	0.3

Note: a      PCBs = Polychlorinated biphenyls. Total PCBs are based on the sum of 23 congeners  
b      PCDDs/PCDFs = Polychlorinated dibenzodioxins/Polychlorinated dibenzofurans  
c      - = not sampled  
d      < = less than  
e      SVOCs = Semi-volatile organic compounds

**TABLE C-2**  
**HAZEN HOLOFLITE® DRYER COMPOSITE SEDIMENT-OUT SAMPLE RESULTS**

Analyte (parts per million)	Sample Identification					
	HZB1SO	HZB2SO	HZB3SO	HZB4SO	HZB5SO	HZB6SO
Total PCBs <sup>a</sup>	14	14	12	14	14	14
Total PCDDs/PCDFs <sup>b</sup>	0.047	- <sup>c</sup>	-	0.055	0.054	-
Arsenic	8	7.5	7.9	8.3	7.9	8.6
Barium	81	81	83	77	73	80
Cadmium	0.9	0.91	0.89	0.95	0.94	1.0
Chromium	37	37	37	34	34	37
Mercury	0.89	0.94	0.8	0.82	0.87	0.84
Lead	70	68	69	72	67	75
Selenium	5.4	5.5	4.8	5.1	6	6.3
Silver	<2.1 <sup>d</sup>	<2.1	<2.2	<2.1	<2.1	<2.1
Total SVOCs <sup>e</sup>	2.3	1.8	-	2.7	2.5	1.4

Note: a      PCBs = Polychlorinated biphenyls. Total PCBs are based on the sum of 23 congeners  
b      PCDDs/PCDFs = Polychlorinated dibenzodioxins/Polychlorinated dibenzofurans  
c      - = not sampled  
d      < = less than  
e      SVOCs = Semi-volatile organic compounds

**TABLE C-3**  
**HAZEN HOLOFLITE® DRYER CONDENSATE-OUT COMPOSITE SAMPLE RESULTS**

Analyte (parts per million)	Sample ID					
	HZB1CO	HZB2CO	HZB3CO	HZB4CO	HZB5CO	HZB6CO
Total PCBs <sup>a</sup>	0.53	0.47	0.21	0.30	0.50	0.57
Total PCDD/PCDFs <sup>b</sup>	4.0 x 10 <sup>-6</sup>	- <sup>c</sup>	-	7.5 x 10 <sup>-6</sup>	1.7 x 10 <sup>-5</sup>	1.4 x 10 <sup>-5</sup>
Arsenic	0.04	0.018	-	0.026	0.021	-
Barium	0.016	0.023	-	0.015	0.014	-
Cadmium	<0.01 <sup>d</sup>	<0.01	-	<0.01	<0.01	-
Chromium	<0.02	<0.02	-	<0.02	<0.02	-
Mercury	0.0003	0.00023	-	<0.0002	0.00023	-
Lead	<0.005	0.009	-	0.0061	0.0077	-
Selenium	<0.01	<0.01	-	<0.01	<0.01	-
Silver	<0.01	<0.01	-	<0.01	<0.01	-
Total SVOCs <sup>e</sup>	0.22	0.23	-	0.15	0.21	0.29

Note: a      PCBs = Polychlorinated biphenyls. Total PCBs are based on the sum of 23 congeners  
b      PCDDs/PCDFs = Polychlorinated dibenzodioxins/Polychlorinated dibenzofurans  
c      - = not sampled  
d      < = less than  
e      SVOCs = Semi-volatile organic compounds



**TABLE C-4**  
**HAZEN HOLOFLITE® DRYER AIR SAMPLE RESULTS**

Sample ID <sup>a</sup>	Parameter									
	Total PCDDs/ PCDFs <sup>d</sup> (ng) <sup>e</sup>	Arsenic (ppm)	Barium (ppm)	Cadmium (ppm)	Chromium (ppm)	Mercury (ppm)	Lead (ppm)	Selenium (ppm)	Silver (ppm)	Total SVOCs <sup>f</sup> (µg) <sup>g</sup>
300267	1.43									
300270	1.25									
300272	1.77									
300274	0.74									
300277	2.54									
300280	2.96									
300283										82
300285										64
300287										220
300289										198
300291										207
300293										225
300319		<0.004 <sup>h</sup>	<0.01	<0.01	<0.02	<0.0002	<0.005	<0.01	<0.01	
300320		<0.004	<0.01	<0.01	<0.02	<0.0002	<0.005	<0.01	<0.01	
300321						0.023				
300322						<0.0002				

Sample ID <sup>a</sup>	Parameter									
	Total PCDDs/PCDFs <sup>d</sup> (ng) <sup>e</sup>	Arsenic (ppm)	Barium (ppm)	Cadmium (ppm)	Chromium (ppm)	Mercury (ppm)	Lead (ppm)	Selenium (ppm)	Silver (ppm)	Total SVOCs <sup>f</sup> (µg) <sup>g</sup>
300323						<0.0002				
300327						<0.0002				
300328		<0.004	<0.01	<0.01	<0.02	<0.0003	<0.005	<0.01	<0.01	
300329		<0.004	<0.01	<0.01	<0.02	<0.0003	<0.005	<0.01	<0.01	
300330						0.048				
300331						<0.0002				
300332		<0.004	<0.01	<0.01	<0.02	<0.0002	<0.005	<0.01	<0.01	
300333						<0.0002				
300334		<0.004	<0.01	<0.01	<0.02	<0.0004	<0.005	<0.01	<0.01	
300335		<0.004	<0.01	<0.01	<0.02	<0.0002	<0.005	<0.01	<0.01	
300336		<0.004	<0.01	<0.01	<0.02	<0.0003	<0.005	<0.01	<0.01	
300337		<0.004	<0.01	<0.01	<0.02	<0.0003	<0.005	<0.01	<0.01	
300338						0.038				
300339						<0.0002				
300340		<0.004	<0.01	<0.01	<0.02	<0.0003	<0.005	<0.01	<0.01	

Sample ID <sup>a</sup>	Parameter									
	Total PCDDs/PCDFs <sup>d</sup> (ng) <sup>e</sup>	Arsenic (ppm)	Barium (ppm)	Cadmium (ppm)	Chromium (ppm)	Mercury (ppm)	Lead (ppm)	Selenium (ppm)	Silver (ppm)	Total SVOCs <sup>f</sup> (µg) <sup>g</sup>
300341		<0.004	<0.01	<0.01	<0.02	<0.0002	<0.005	<0.01	<0.01	
300342						0.12				
300343						<0.0002				

Notes: a ID = Identification  
b PCBs = Polychlorinated biphenyls. Total PCBs are based on the sum of 23 congeners.  
c ppm = parts per million  
d PCDDs /PCDFs = Polychlorinated dibenzodioxins/Polychlorinated dibenzofurans  
e ng = Nanogram  
f SVOCs = Semivolatile organic compounds  
g µg = Microgram  
h < = Less than

